ITS Field Operational Test Summary
TRANSCOM System for Monitoring Incidents and Traffic

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Introduction

The TRANSCOM System for Managing Incidents and Traffic (TRANSMIT) ITS Field Operational Test provided travel time information and remote incident detection on twelve miles of the New York State Thruway (NYST) and seven miles of the Garden State Parkway (GSP). The TRANSMIT test assessed the feasibility of using existing electronic toll collection (ETC) equipment (also known as electronic toll and traffic management equipment) to facilitate traffic surveillance and incident detection. TRANSMIT collected this information by capturing and analyzing successive reads of existing ETC transponders to determine traffic flow characteristics.

The Transportation Operations Coordinating Committee (TRANSCOM) is a coalition of fourteen highway, transit, and public safety agencies in the New York/New Jersey/Connecticut area. The Committee has become a major repository and purveyor of region-wide transportation data. TRANSCOM deployed the TRANSMIT system between early 1995 and mid 1996.

Project Description

The existing ETC system in the New York area allows motorists to use electronic transponders on their vehicles. As the vehicle approaches a toll facility (thruway toll plaza, bridge, or tunnel), equipment at the facility reads the transponder identification signal and debits the motorist's account for the amount of the toll. On the New York State Thruway west of the Tappan Zee Bridge, as many as 3,500 vehicles per hour use the existing ETC. On the Garden State Parkway, over 250 vehicles per hour have been detected, even though the Parkway does not yet support ETC.

TRANSMIT used existing ETC equipment to provide traffic speed and incident detection information to TRANSCOM's Operations Information Center (OIC). On 19 miles of roadway approaching New York City, TRANSMIT installed 22 transponder readers at between 0.5 and 2.1-mile intervals in both travel directions. As a transponder-equipped vehicle passed one of the overhead antennas of the transponder readers, the system read the vehicle's identification signal. The system recorded the identification number and detection time of the vehicle. It sent this information, along with the location of the reader and the lane position of the vehicle, to the OIC.

At the OIC, the system encoded the vehicle identification number into a random number to protect the privacy of the motorist. As the vehicle continued along the highway, it passed additional transponder readers that repeated this process. Figure 1 presents a schematic of the system.

At the OIC, a computer processed the series of arrival times for each equipped vehicle. The computer software calculated the travel time between the readers and averaged the travel times of all vehicles passing between two readers to establish an average traffic speed for that section of highway. The computer stored this travel time information for use in traffic flow analysis. Over time, TRANSCOM built a historical database of traffic speeds by time of day (in 15-minute

intervals). This database was further classified by type of day: weekday, Saturday, Sunday, and holiday.

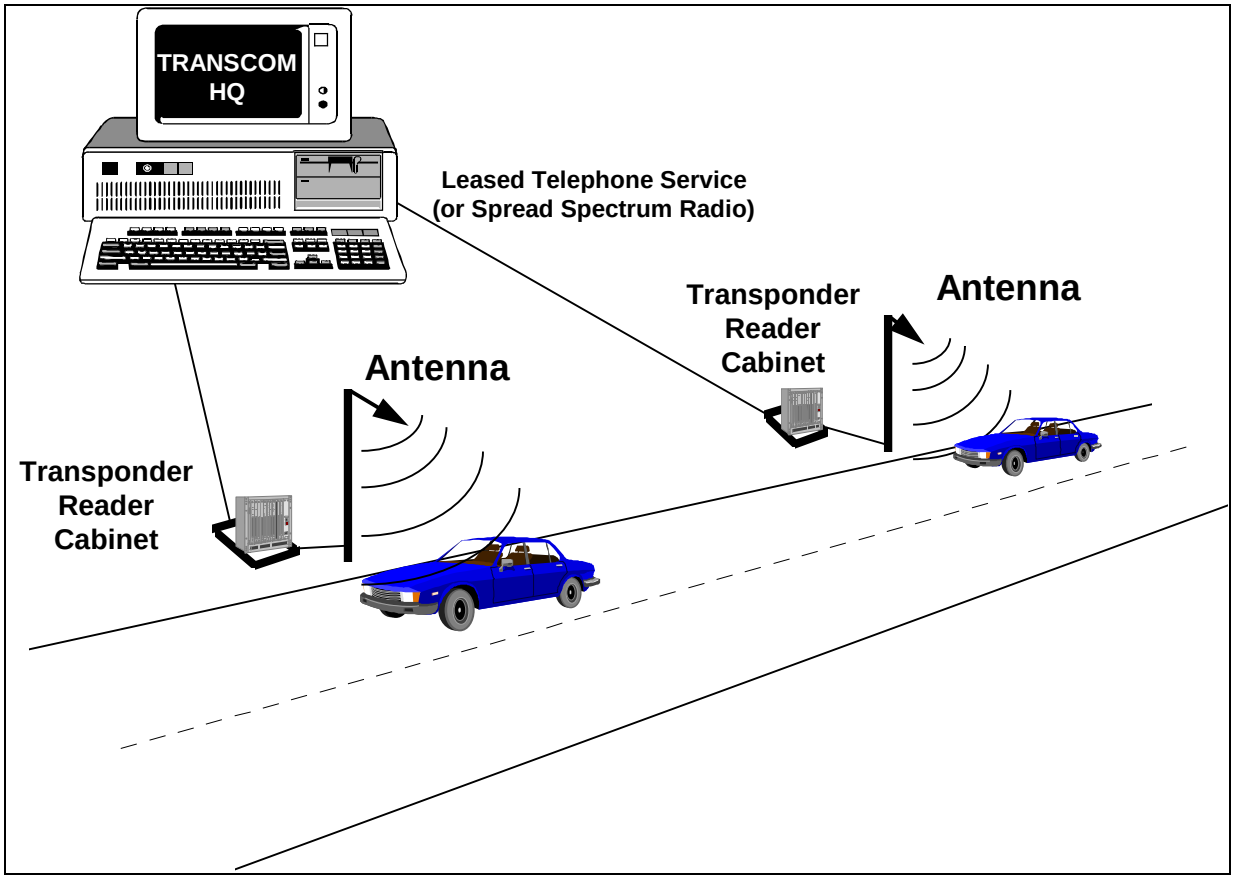

Figure1: TRANSMIT System Schematic

TRANSCOM's computer system employed a speed-based incident detection algorithm. The algorithm compared individual vehicle travel times between pairs of transponder readers to the historical database times for the corresponding location, time period, and type of day. If the vehicle's travel time was greater than the historical average, the algorithm calculated the probability that an incident had occurred and the probability that there was a false alarm. As part of the development process, test personnel refined the algorithm to reduce the number of false alarms and provide reliable incident detection capabilities.

Results

An independent evaluator assessed the operation of the system from January to April 1996 and supplemented that data with additional data in September and October 1996. The evaluation of the test included an analysis of the system's capabilities in communication, incident detection, and estimating traffic parameters. The evaluation also examined the system's costs, benefits, and institutional issues. The evaluation of the capabilities of the system was very positive.

The communications system functioned extremely well, both in terms of the transmission rate and the detection rate. The transmission rate is the ratio of vehicle identification data received at the OIC to that recorded at the transponder reader location. For all transponder reader locations

except one, the transmission rate ranged from 98.8% to 100%. The single exception had a rate of 88%. This site was the only one to use spread spectrum radio communications. The evaluator found that the system's current capacity is capable of handling the maximum possible traffic flow conditions without any constraints. The detection rate is the ratio of the number of readings recorded at the transponder reader location to the number of known transponder equipped vehicles passing the location. The majority of transponder readers had detection rates near 100%. A few locations had detection rates ranging from 28% to 61%. The evaluator felt that these results indicated specific site problems and recommended that the antenna orientation at these sites be investigated.

The system estimated two traffic parameters: link mean travel time and link space mean speed. Evaluators compared the recorded travel times as observed by the transponder readers to the actual travel times of test vehicles. The evaluation of these parameters showed that 92% of the travel times were within three seconds of each other. The evaluators concluded that the system could accurately provide direct estimates of the link travel time and link space mean speed.

The incident detection algorithm successfully identifies incidents along the instrumented sections of the highways. Along the NYST during February to April of the evaluation period, the system detected incidents at a rate of 91% to 95%. Along the GSP during the same time, the probability of detection ranged from 67% to79%. The system also exhibited a low probability of false alarms. On the NYST, this probability was 6% to 33%. On the GSP, the probability was 0% to 67%. The probability of false alarms varies widely on the GSP because of the small sample size (nine alarms) on that highway. The TRANSMIT system has an incident detection capability that compares very favorably to those reported in literature and its false alarm rates are better than any reported from other systems.

The evaluator compared the hardware, installation, maintenance and operation costs of the TRANSMIT system to other systems using Inductive Loop Detection (ILDS), Video Image Detection (VIDS), and Microwave Radar Detection (MRDS). The following table shows that TRANSMIT costs are substantially less than those of other types of systems are. (Costs are compared for a typical installation per detection site across a six-lane highway.)

Description	TRANSMIT	ILDS	VIDS	MRDS
Capital Cost:				
Hardware Costs	$14,700	$4,100	$24,500	$26,500
Installation Costs	$21,700	$50,560	$45,100	$25,200
Total Capital Cost:	**$35,400**	**$54,660**	**$69,600**	**$51,700**
Maintenance Costs/Year	$2,900	$7,950	$3,300	$2,900
Operations Costs/Year	$2,040	$2,040	$2,040	$2,040
Total Annual Cost:	**$4,940**	**$9,950**	**$5,340**	**$4,940**
Total Cost for One Year:	**$41,340**	**$64,650**	**$74,940**	**$56,640**

The TRANSMIT system provides several significant current and potential benefits. The system's current capabilities provide the benefits of

- Accurate, automated incident detection, and
- Accurate traffic flow parameter estimation.

In addition, the system can provide (without any substantial hardware or software modifications and costs) the following traffic flow characteristics:

- Vehicle position estimation and tracking
- Path travel time estimation
- Origin-Destination matrix direct estimation
- Traffic volume estimation

The evaluator also concluded that the benefits of the system would increase as more toll facilities in the metropolitan area adopt the use of the ETC equipment.

The evaluator identified two significant institutional issues that surfaced during the development and implementation of the TRANSMIT system. One issue involved the administration of the project. The TRANSMIT partnership is a cooperative effort between several public agencies and private organizations. To efficiently resolve technical incompatibilities, the partners adopted an alternative contracting approach that employed a consultant to supervise and administer the project. This approach allowed the flexibility to resolve administrative and technical problems and reduced implementation time.

A second issue involved the privacy of the motorists traveling along the project highways. TRANSCOM established a requirement for the privacy of the identity of the vehicles equipped with the ETC equipment prior to the implementation of the project. To achieve this requirement, the system encoded the identification number of the vehicle as soon as the number was received at the OIC. This policy avoided possible negative public reaction towards the system.

Legacy

The TRANSMIT system has continued to operate successfully since the conclusion of the testing phase.

Engineers and operators at the TRANSCOM partner highway agencies have successfully applied TRANSMIT as a tool to improve their respective traffic management operations. TRANSMIT provides a significant amount of information that is useful to alert motorists to potential highway congestion and to initiate traffic management actions. Engineers and system operators use the speed and travel time information to document the varying levels of congestion on the network. The information helps them identify bottleneck locations and develop solutions to address the problems. System administrators use the speed and volume information to help establish tollbooth staffing levels by time and type of day.

In addition to the incident detection potential, TRANSMIT operators have also used the historical information in the database to help respond to citizen complaints and legislative inquiries and to better understand how the road network and the traffic management systems operate.

Traffic managers use the system for day-to-day incident detection and traffic management operations. The system is providing managers with accurate traffic speed information. TRANSCOM has obtained support for a second phase of the project in which it will expand the

use of TRANSMIT to a total of 150 miles of roadways. The expansion will include highways east of the Tappan Zee Bridge and highways approaching, crossing, and leaving Staten Island.

Test Partners

Edwards & Kelsey

Federal Highway Administration

Garden State Parkway

Mark IV

New Jersey Highway Authority

New York State Thruway Authority

PB Farradyne

TRANSCOM

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